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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Volker MOEBIUS et al.
Serial No.	:	Not yet known (U.S. National Stage of PCT/DE01/01331 filed April 3, 2001)
Filed	:	Concurrently herewith
For	:	METHOD FOR CONTROLLING MECHANISMS AND TECHNICAL SYSTEMS, A CORRESPONDING DEVICE AND CONTROL SOFTWARE

U.S. Patent and Trademark Office
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PRELIMINARY AMENDMENT

Sir:

Preliminary to examination, please amend the above-identified patent application as follows:

IN THE CLAIMS:

Amend claims 1-17 as follows, the amendments being shown by brackets and underscoring in the Appendix hereto:

1. Method for the control of a mechanism or technical system, comprising

a) storing the mechanism or technical system to be controlled in a control by way of its elementary functions with states thereof

defined according to instructions and appropriate signal vectors of sensors and actuators, whereby starting from a defined reference state at a beginning of control activation a continuous comparison is made of an actual state of the mechanism or technical equipment transmitted by the sensors with a desired state stored in the control for all elementary functions whereby any deviation in the system to be controlled from the desired state according to the instructions is detected, and

b) by means of a new elementary instruction that changes the state of the mechanism or technical system with its start updating the desired state for the comparison and monitoring a time period until acknowledgment of a new state according to the instruction, based on also stored permissible control time periods, and

c) wherein sensor signals and comparable information serve exclusively to identify states of elementary functions, state changes exclusively occur through the start of elementary instructions, to which signals from the sensors and the actuators are assigned as a desired state and application instructions freely defined on logical-functional language level are defined by appropriate assignment of elementary instructions.

2. Method according to to Claim 1

wherein

in a special program module comprising an EF-controller, managing the states of all the elementary functions as ordered actual desired states and as current actual states with appropriate ones of the actuators and of the sensors,

whereby any change in the state of the mechanism or technical system detected through the sensors is therefore assigned to the concerned elementary function as current actual state and can be compared with the desired state managed in the control and evaluated.

3. Method according to Claim 1 or 2, wherein

a) for a detected actual state of an elementary function that is not equivalent to the desired state, transferring the signal vector that describes the actual state to another special program module of the control comprising a not-desired state evaluator,

b) in the not-desired state evaluator storing reaction instructions for selected states of elementary functions that are started on equivalence with the state that was transferred for check, and

c) producing special error messages that indicate the name of the elementary function concerned and a deviating signal.

4. Method according to Claim 3, wherein

to an application instruction, as an instruction set the new desired states of the sensors and actuators, control times for the new desired state as well as reaction instructions to be started in case of deviations are assigned, classified, in each case, as reaction instructions for selected state messages, to be deleted and set prior to the start and after the execution, respectively,

whereby another special program module of the control comprising an instruction starter takes on required organization in the system, and thus also release of a next instruction in case of instruction sequences after an execution message of a previous instruction as well as organization of parallel instructions by temporary opening, as necessary, of parallel execution sequences are effected.

5. Method according to Claim 4, wherein

a) in another program module comprising a state monitor, sensor signals and other information to be controlled are integrated into a continuous data word, whereby the address of an appropriate elementary function in the EF-controller of the control maintains assigned to the signals,

b) for the comparison, each desired signal is faced by the actual signal of the sensor message in equal structure,

c) for a detected deviation of an actual signal, the module state monitor updates the actual signal in the EF-controller as the new actual state of an elementary function,

d) and after the updating and transmission for evaluation in the EF-controller the updated signal is entered as a new comparison state in the state monitor so that a comparison in the state monitor is always made to the state evaluated last and hence each change in state is evaluated only once,

e) whereby comparison of the desired and actual signals in the state monitor is made directionally and after an interruption for the evaluation of a deviation the comparison is continued at the signal succeeding the interruption place, which ensures that each state

change that is sufficiently long in time can be detected and evaluated.

6. Method according to Claim 5

a) each recorded state change is entered by the program module state monitor in an event-time protocol and can be stored there,

b) whereby in the simplest way time-dependent process parameters become accessible so that also signal vibrations can be detected and, if necessary, filtered out.

7. Method according to Claim 6, wherein

a) a subdomain execution computer with the instruction starter, EF-controller, not-desired state evaluator and state monitor after transmission of an elementary instruction to the instruction starter in the control includes no check for permissibility,

b) the execution of a received instruction is, in each case, autonomously realized by the program modules assigned to the execution computer,

c) in a subdomain instruction computer of the control blocking lists for mutually exclusive states are managed on the logical-functional instruction level, which take on that proportion of functional blockings that is determined by process and machine sides,

d) whereby an application instruction, in addition to elementary functions to be changed also contains the information, for which other instructions blockings are to be set or deleted in the blocking list during or after the execution of the application instruction.

8. Method according to Claim 7, wherein

the execution computer and the instruction computer work decoupled in time by one program step,

a) the executing part of the control comprising the execution computer executes a received instruction autonomously, whereby an instruction-managing part of the control comprising the instruction computer, makes a checked next instruction available to the executing part comprising the execution computer in an intermediate storage as instruction buffer

b) and after provision of an instruction in the instruction buffer of the execution computer the state in the instruction computer is updated to the condition that will be after the execution of this instruction,

and the check to this expected state of the then subsequent instruction for permissibility in the instruction computer is made already during the execution of the preceeding instruction, and

c) if due to an error the expected state does not appear, the checked instruction from the instruction buffer is reset and the system updated to error state.

9. Method according to Claim 8, wherein

application instructions are prepared

a) by assigning to the application instructions to be functionally defined close to the process by language, from the previously defined elementary instructions, such elementary instructions single, parallel or as a sequence,

b) by defining the blocking conditions on instruction level for the updatings to be made when activating the application instruction, in the blocking list in the instruction computer,

c) by determining the reaction instructions for selected deviations and suitable error messages, and

d) by filing this information in an instruction library, where the control calls the instruction contents for application instructions.

10. Method according to Claim 9, wherein

an application program for the operation of the mechanism or the technical system determines the sequence of defined application instructions that are to be executed one after the other or in parallel.

11. Method for the development of control software for a mechanism or control system, in which

the development of the control software is supported by a development system with dialogue ability, comprising

a) for the description of the system to be controlled requesting the data of the hierarchical function structure,

b) considering each lower end of the hierarchical structure as elementary function and each elementary function is to be defined with their instruction states also in a dialogue,

c) whereby to these defined elementary instructions, the signals of sensors, of actuators, control times for transition between the states according to the instructions, and a reference state are to be assigned,

d) the integration of more complex partial systems being also performable as elementary function if the position in the function structure indicates this,

e) whereby the dialogue system requires only the primary data listed on the structure and elementary functions as the basis for the description of the functionality of the mechanism or the technical system.

12. Method according to Claim 11, wherein

the dialogue-guided development system after entry of primary data establishes and generates

a) a system elementary instruction storage,

b) the EF-controller and

c) desired signal vector and the actual signal vector for the state monitor and thus the mechanism or the technical system can already be put into operation, checked for error-free signal definition in the reference state and controlled with defined elementary functions in

a state of putting into operation, and be tested and checked as far as permissible with regard to these single instructions.

13. Method according to Claim 12, wherein

changes of information on structure and elementary functions are only possible over an editing level and subsequent automatic generation ensures the consistency of the changed state.

14. Method according to Claim 13

characterized in that the development system for the definition of application instructions in specific dialogues

a) offers the available elementary instructions of the system for assignment,

b) requests blocking conditions for the blocking list, whereby the data for blockings to be determined can be given graphically through selection in the function structure and blocking determinations can be given as formulations,

c) determinations on specific reaction instructions are requested for special errors, and

d) all determinations are stored and are classified and managed in the instruction library.

15. Method according to Claim 14, wherein

a) for a control system designed in such a manner changes of elementary functions maintain locally limited,

b) any time, also with calculable local effect, new application instructions, blocking conditions in the blocking list or error reactions by reaction instructions (72) can be entered, extended or changed,

c) differentiated by the assignment of status information, new definitions of application instructions and instruction conditions can be made for the system without any reaction on already defined programs.

16. Apparatus for control of a mechanism or a technical system, comprising

a) different domains for different problems, said domains being configured dependent on the most important features of the

problems, whereby, particularly short times of reaction to detected events and reliable program runs are achieved,

b) an execution computer and program modules for all time-critical problems of the control, comprising instruction starter, EF-controller, not-desired state evaluator and state monitor arranged in the execution computer,

c) the execution computer, in case of voluminous programs with great program variability, has a dedicated processor for time-critical problems,

d) sensors and actuators, the execution computer being autonomous for communication with devices to be controlled through the sensors, activation of the actuators, desired/actual state comparison, reactions to deviations of the actual state from the desired state and execution of a received instruction,

e) if the execution computer has a dedicated processor, another processor for management of application instructions in instruction libraries, management of blocking lists, execution of application programs by step-by-step transmission of instructions to the execution computer and external communication from the domain of a device comprising an instruction computer, and

f) for problems of process design, unless they concern the execution or instruction computer, a domain application computer.

17. Apparatus according to Claim 16, further comprising

a) for small-scale controls with a small instruction volume and uncritical time requirements, a control hardware module having fixed instruction sets, the execution computer and the instruction computer being included in the control hardware module,

b) switching and indication devices for operation and communication, and

c) an interface adapted for coupling with an external computer for entering control software.

IN THE ABSTRACT:

Please replace the abstract with the substitute abstract submitted on a separate page appended hereto.

ABSTRACT

In a method for controlling mechanisms or technical systems, the mechanisms or technical systems to be controlled are stored in a controller with their states, and with associated signal formers of sensors and actuators, whereby starting from a defined reference state at the onset of the activation of the controller, the actual states signaled by the technical system via the sensors are continuously compared with the specified state, the specified state being stored in the controller, and, based on this comparison, every deviation from the specified state is identified in the technical system, and, when initiated, a new instruction that changes the state of the mechanisms or of the technical system updates the specified state for the comparison and monitors the time till the acknowledgment of the new state, and sensor signals and comparable information exclusively serve the state identification of elementary functions and state changes exclusively ensue upon the initiation of elementary instructions.

REMARKS

A number of formal amendments have been made to the claims, including the elimination of reference numbers, which may have an unduly limiting effect under U.S. practice, conforming of claim dependencies to U.S. practice, positive recitation of claim elements and provision of antecedent bases. A good faith effort has been made in these respects though the possibility is, of course, recognized that further amendment may be necessary during prosecution in view of the disparity between European and U.S. claiming practice.

An abbreviated Abstract has been substituted to comply with the USPTO requirement that the Abstract not exceed approximately 150 words.

Respectfully submitted,

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APPENDIX I

AMENDED CLAIMS WITH AMENDMENTS INDICATED THEREIN
BY BRACKETS AND UNDERLINING

1. Method for the control of [mechanisms] a mechanism or technical [systems] system, comprising

[characterized in that]

a) storing the [mechanisms] mechanism or technical [systems] system to be controlled [are stored] in [the] a control by way of [their] its elementary functions [(8)] with [the] states thereof defined according to [the] instructions and [the] appropriate signal vectors [(15)] of [the] sensors [(13)] and actuators [(12)], whereby starting from a defined reference state [(18)] at [the] a beginning of [the] control activation a continuous comparison is made of [the] an actual [states] state [transmitted] of the mechanism or technical equipment transmitted by the sensors [(13)] with [the] a desired [states (24)] state stored in the control for all elementary functions [and hence] whereby any deviation in the system to be controlled from the desired state [(24)] according to the instructions is detected, and

b) by means of a new elementary instruction [(16)] that changes the state of the [mechanisms] mechanism or [the] technical system with

its start [updates] updating the desired state [(24)] for the comparison and [monitors the] monitoring a time period until [the] acknowledgment of [the] a new state according to the instruction, based on also stored permissible control time periods [(17)], and

c) [whereby] wherein sensor signals and comparable information serve exclusively to identify states of elementary functions [(8)], state changes exclusively occur through the start of elementary instructions [(16)], to which signals from the [sensor] sensors and [actuator signals] the actuators are assigned as a desired state and [the] application instructions [(32)] freely defined on logical-functional language level are defined by [the] appropriate assignment of elementary instructions [(16)].

2. Method according to to Claim 1

[characterized in that] wherein

[a) in the control] in a special [programme] program module [here referred to as EF-controler (23)] comprising an EF-controller, managing the states of all the elementary functions [(8) are managed] as ordered actual desired states [(24)] and as current actual states [(25)] with [the] appropriate ones of the actuators [(12)] and of the sensors [(13)],

[b)] whereby any change in the state of the mechanism or technical system detected through the sensors [(13)] is therefore assigned to the concerned elementary function [(8)] as current actual state and can be compared with the desired state [(24)] managed in the control and evaluated.

3. Method according to [Claims] Claim 1 or 2, wherein

[characterized in that]

a) for a detected actual state [(25)] of an elementary function [(8)] that is not equivalent to the desired state [(24)], transferring the signal vector [(15)] that describes the actual state [is handed over] to another special [programme] program module of the control[, here referred to as] comprising a not-desired state evaluator [(38)],

b) [whereby] in [this] the not-desired state evaluator [(38)] storing reaction instructions [(72) are stored] for selected states of elementary functions [(8)] that are started on equivalence with the state that was [handed over] transferred for check, and

c) [and in all cases,] producing special error messages [are produced] that indicate the name of the elementary function concerned and [the] a deviating signal.

4. Method according to [Claims 1 to] Claim 3, wherein

[characterized in that]

[a)] to an application instruction [(32)], as an instruction set the new desired states [(24)] of the sensors [(13)] and actuators [(12)], [die] control times [(17)] for the new desired state [(24)] as well as [the] reaction instructions [(72)] to be started in case of deviations are assigned, classified, in each case, as reaction instructions [(72)] for selected state messages, to be deleted and set prior to the start and after the execution, respectively,

[b)] whereby another special [programme] program module of the control[, here referred to as] comprising an instruction starter [(35),] takes on [the] required organization in the system, and thus also [the] release of a next instruction in case of instruction sequences after [the] an execution message of [the] a previous instruction as well as [the] organization of parallel instructions [(45)] by temporary opening, as necessary, of parallel execution sequences are [realized] effected.

5. Method according to [Claims 1 to] Claim 4, wherein

[characterized in that]

a) in another [programme] program module[, here referred to as] comprising a state monitor [(37)], sensor signals [(13)] and other information to be controlled are integrated into a continuous data word, whereby the address of [the] an appropriate elementary function [(8)] in the [EF-controler (36)] EF-controller of the control maintains assigned to the signals,

b) for the comparison, each desired signal [(30)] is faced by the actual signal [(31)] of the sensor message in equal structure,

c) [whereby] for a detected deviation of an actual signal, the [programme] module state monitor [(37)] updates [this] the actual signal in the [EF-controler (36)] EF-controller as the new actual state of [the] an elementary function [(29)],

d) and after the updating and transmission for evaluation in the [EF-controler (36)] EF-controller the [changed] updated signal is entered as [the] a new comparison state in the state monitor [(37)] so that a comparison in the state monitor [(37)] is always made to the state evaluated last and hence each change in state is evaluated only once,

e) whereby [the] comparison of the desired and actual signals [(30, 31)] in the state monitor [(37)] is made directionally and after an interruption for the evaluation of a deviation the comparison is

continued at the signal succeeding the interruption place, which ensures that each state change that is sufficiently long in time can be detected and evaluated.

6. Method according to [Claims 1 to] Claim 5

[characterized in that]

a) each recorded state change is entered by the [programme] program module state monitor [(37)] in an event-time protocol [(85)] and can be stored there,

b) whereby in the simplest way time-dependent process parameters become accessible so that also signal vibrations can be detected and, if necessary, filtered out.

7. Method according to [Claims 1 to] Claim 6, wherein

[characterized in that]

a) [the] a subdomain execution computer [(2)] with the [programme modules] instruction starter [(35)], [EF-controler (36)]EF-controller, not-desired state evaluator [(38)] and state monitor [(37)] after transmission of an elementary instruction [(16)] to the [programme module] instruction starter [(35)] in the control includes no check for permissibility,

b) the execution of a received instruction is, in each case, autonomously realized by the [programme] program modules assigned to the execution computer [(2)],

c) in [the] a subdomain instruction computer [(3)] of the control blocking lists [(88)] for [the] mutually exclusive states are managed on the logical-functional instruction level, which take on that proportion of functional blockings that is determined by [the] process and machine sides,

d) whereby an application instruction [(32)], in addition to elementary functions [(8)] to be changed also contains the information, for which other instructions blockings are to be set or deleted in the blocking list [(88)] during or after the execution of [this] the application instruction [(32)].

8. Method according to [Claims 1 to] Claim 7, wherein

[characterized in that] the execution computer [(2)] and the instruction computer [(3)] work decoupled in time by one [programme] program step,

a) the executing part of the control[,] comprising the execution computer [(2),] executes a received instruction autonomously, whereby an instruction-managing part of the control[,] comprising the instruction computer [(3)], makes [the] a checked next

instruction available to the executing part comprising the execution computer [(2)] in an intermediate storage as instruction buffer [(34),]

b) and after provision of an instruction in the instruction buffer [(34)] of the execution computer [(2)] the state in the instruction computer [(3)] is updated to the condition that will be after the execution of this instruction, and the check to this expected state of the then subsequent instruction for permissibility in the instruction computer [(3)] is made already during the execution of the preceeding instruction, and

c) if due to an error the expected state does not appear, the checked instruction from the instruction buffer [(34)] is reset and the system updated to error state.

9. Method according to [Claims 1 to] Claim 8, wherein

[characterized in that] application instructions [(32)] are prepared

a) by assigning to the application instructions [(32)] to be functionally defined close to the process by language, from the previously defined elementary instructions [(16)], such elementary instructions single, parallel or as a sequence,

b) by defining the blocking conditions on instruction level for the updatings to be made when activating the application instruction [(32)], in the blocking list in the instruction computer [(88)],

c) by determining the reaction instructions [(72)] for selected deviations and suitable error messages, and

d) by filing this information in an instruction library [(92)], where the control calls the instruction contents for application instructions [(32)].

10. Method according to [Claims 1 to] Claim 9, wherein

[characterized in that]

an application [programme (93)] program for the operation of the mechanism or the technical system determines the sequence of defined application instructions [(32)] that are to be executed one after the other or in parallel.

11. Method for the development of control software for a mechanism or control system, in which

[characterized in that]

the development of the control software is supported by a development system with dialogue ability, comprising

a) [whereby] for the description of the system to be controlled requesting the data of the hierarchical function structure [(5) is requested],

b) considering each lower end of [this] the hierarchical structure [is considered] as elementary function [(8)] and each elementary function [(8)] is to be defined with their instruction states also in a dialogue,

c) whereby to these defined elementary instructions [(16)], the signals of [the] sensors [(13)], of [the] actuators [(12)], [the] control times [(17)] for [the] transition between the states according to the instructions, and a reference state [(18)] are to be assigned,

d) the integration of more complex partial systems [can] being also [be performed] performable as elementary function [(8)] if the position in the function structure [(5)] indicates this,

e) whereby the dialogue system requires only the primary data listed [here] on the structure [(5)] and elementary functions [(9)] as the basis for the description of the functionality of the mechanism or the technical system.

12. Method according to [Claims] Claim 11, wherein

[characterized in that]

the dialogue-guided development system after entry of [the] primary data establishes and generates

a) [the] a system elementary instruction storage [(21)],

b) the [EF-controler (36)] EF-controller and

c) [the] desired signal vector [(30)] and the actual signal vector for the state monitor [(37)] and thus the mechanism or the technical system can already be put into operation, checked for error-free signal definition in the reference state [(18)] and controlled with [the] defined elementary functions [(16)] in a state of putting into operation, and be tested and checked as far as permissible with regard to these single instructions.

13. Method according to [Claims 11 or] Claim 12, wherein

[characterized in that]

changes of information on structure [(5)] and elementary functions [(8)] are only possible over [the] an editing level [(19)] and [the] subsequent automatic generation ensures the consistency of the changed state.

14. Method according to [Claims 11 to] Claim 13

characterized in that the development system for the definition of application instructions [(32)] in specific dialogues

a) offers the available elementary instructions [(16)] of the system for assignment,

b) requests blocking conditions for the blocking list [(88)], whereby the data for blockings to be determined can be given graphically through selection in the function structure [(5)] and blocking determinations can be given as formulations [such as "this elementary instruction", "this elementary function", "this branch of the function structure" or "all functions of this function branch except this elementary instruction"],

c) determinations on specific reaction instructions [(72)] are requested for special errors, and

d) all determinations are stored and are classified and managed in the instruction library [(92)].

15. Method according to [Claims 11 to] Claim 14, wherein

[characterized in]

a) [that] for a control system designed in such a manner changes of elementary functions [(8)] maintain locally limited,

b) [that] any time, also with calculable local effect, new application instructions [(32)], blocking conditions in the blocking list [(88)] or error reactions by reaction instructions (72) can be entered, extended or changed,

c) [that] differentiated by the assignment of status information [(90)], new definitions of application instructions [(32)] and instruction conditions can be made for the system without any reaction on already defined [programmes] programs.

16. [Equipment] Apparatus for [the] control of [mechanisms] a mechanism or a technical [systems] system, comprising

[characterized in]

a) [that for the] different domains for different problems [different domains of the device are provided and these], said domains [are] being [configurated] configured dependent on the most important features of the problems, whereby, particularly[,] short times of reaction to detected events and reliable [programme] program runs are achieved,

b) [that the programme] an execution computer and program modules for all time-critical problems of the control, comprising instruction starter [(35)], [EF-controler (36)] EF-controller, not-desired state

evaluator [(38)] and state monitor [(37) are] arranged in [a part of the device here referred to as] the execution computer [(2)],

c) the execution computer [(2)], in case of voluminous [programmes] programs with great [programme] program variability, has [an own] a dedicated processor for [these] time-critical problems,

d) [that] sensors and actuators, the execution computer [(2) is] being autonomous for [the] communication with [the] devices to be controlled [over] through the sensors [(13)], [the] activation of the actuators [(12)], [the] desired/actual state comparison, reactions to deviations of the actual [(25) against] state from the desired state [(24)] and [the] execution of a received instruction,

e) if the execution computer has a dedicated processor, another processor for [the] management of application instructions [(32)] in instruction libraries [(92)], [the] management of blocking lists [(88)], [the] execution of application [programmes (93)] programs by [step-by step] step-by-step transmission of instructions to the execution computer [(2)] and [the] external communication from the domain of [the] a device [here referred to as] comprising an instruction computer [(3), another processor is provided, if the features of c) are valid], and

f) for [the] problems of process design, unless they concern the execution or instruction computer, a domain application computer [(4) is provided].

17. [Equipment] Apparatus according to Claim 16, further comprising [characterized in that]

a) for small-scale controls [(94)] with a small instruction volume and uncritical time requirements [the modules of] , a control hardware module having fixed instruction sets, the execution computer [(2)] and the instruction computer [(3) are] being included in [a] the control hardware module [(95) with fixed instruction sets],

b) switching and indication devices for [the] operation and communication [usual switching and indication devices (961 are provided], and

c) [over] an interface [(97)] adapted for coupling with an external computer [(98)] for entering [the] control software [and, if necessary, for a comfortable communication and diagnosis can be coupled].